TITLE: ENGINEERING A NEW MATERIAL FOR HOT GAS CLEANUP

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GRANT NO.: DE-FG26-99FT40587

PERIOD OF PERFORMANCE: July 1, 1999 – June 30, 2002 DATE: April, 2001

ABSTRACT

OBJECTIVE

The overall objective of this project is the engineering development of a superior calcium-based material for desulfurizing hot coal gas. The material should be capable of removing H_2S and COS from hot gas and should withstand repeated loading and regeneration. The project is built on the results of a previous investigation which showed that a promising material could be made by encasing a limestone pellet within a porous shell of a stronger but largely inert material. Specific tasks include the following:

1. Prepare and test numerous core-in-shell pellets in order to identify the best materials and composition for both the pellet core and pellet shell.
2. Optimize sorbent preparation conditions to obtain a strong, durable and highly reactive material which is also economical to use.
3. Conduct a thorough evaluation of the best sorbent material.

ACCOMPLISHMENTS TO DATE

Previous work showed that a promising sorbent for sulfurous gases can be made by a two-step pelletization process carried out with a drum pelletizer. Spherical pellet cores are produced in the first stage by pelletizing limestone or other calcium-containing particles. In the second stage the cores are coated in the pelletizer with another material which upon further treatment forms a hard protective shell. Initially, limestone was used as a core material and a hydraulic cement was used as a shell material. In order to improve the properties of the sorbent, other materials have been utilized subsequently. Recent work has shown that calcium sulfate hemihydrate is an outstanding material for preparing the core and that a sinterable mixture of powdered alumina and limestone is a very good material for preparing the shell. A unique high temperature treatment converts the calcium sulfate into calcium oxide and the mixture of alumina and limestone into a porous but strong sintered

structure. The resulting core-in-shell pellets appear to have adequate absorption capacity and crushing strength. In addition, the pellets seem to withstand repeated loading and regeneration without appreciable loss of reactivity.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAM

The development of an outstanding calcium-based sorbent for desulfurizing hot coal gas could improve the overall efficiency of integrated coal gasification combined-cycle (IGCC) power generating systems now under development. The ideal sorbent for such applications should be capable of desulfurizing coal gas at nearly gasifier outlet temperatures which may range from 1000 to 1600 K. Also the sorbent should be regenerable and reusable to avoid a huge waste disposal problem, and it should be cost effective. The calcium-based sorbent now under development is likely to meet these challenges.

PLANS FOR THE COMING YEAR

Further development of the core-in-shell sorbent is planned. Preparation conditions will be studied in greater detail to maximize the following properties of the material: absorption capacity, compressive strength, and ability to withstand repeated loading and regeneration.

ARTICLES, PRESENTATIONS, AND STUDENT SUPPORT

Articles

- T.T. Akiti, Jr., K. P. Constant, L. K. Doraiswamy, and T. D. Wheelock, "Development of an Advanced Calcium-based Sorbent for Hot Coal Gas," *Advances in Environmental Research* (in press).
- T.T. Akiti, Jr., K. P. Constant, L. K. Doraiswamy, and T. D. Wheelock, "An Improved Core-in-Shell Sorbent for Desulfurizing Hot Coal Gas," *Advances in Environmental Research* (in press).

Conference Presentations

- T.T. Akiti, Jr., and T.D. Wheelock, "Development of a core-in-shell sorbent for desulfurizing hot coal gas," presented at the Annual Meeting of the Iowa Academy of Science, Des Moines, Iowa, April 21, 2000.
- J. Zhu, D. Hasler, and K. Constant, "Calcia and alumina composites for desulfurization of high temperature coal gas," presented at the Annual Meeting of the Iowa Academy of Science, Des Moines, Iowa, April 21, 2000.
- D. Hasler, K. Constant, and T. D. Wheelock, "A calcium-based sorbent for high temperature desulfurization," presented at the Annual Meeting of the Iowa Academy of Science, Des Moines, Iowa, April 20, 2001.

Students Supported under this Grant

- T.T. Akiti, Jr., a graduate (Ph.D.) student in chemical engineering at Iowa State University
- David Hasler, a graduate (Ph.D.) student in chemical engineering at Iowa State University
- J. Zhu, a graduate (M.S.) student in materials science and engineering at Iowa State University
- Stephen Dak, an undergraduate student in chemical engineering at Iowa State University